# Earth Science

Rockhounds' NATIONAL Magazine

**DOWNERS GROVE HIGH SCHOOL**
**Location of the**
**18th ANNUAL CONVENTION**
**MIDWEST FEDERATION of MINERALOGICAL and GEOLOGICAL SOCIETIES**

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CONTENTS, JUNE ISSUE, 1958



COMING IN EARLY ISSUES

"Gem Cutting" (an illustrated series) by Dr. J. D. Willems; "How High Can You Get" by Ben Hur Wilson; "Age Of The Earth" by Earl D. Cornwell.

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# Editor's Memo Pad

CONVENTION TIME: Convention time is here again. One National and six Regional Conclaves, widely scattered throughout the country should give everyone who may wish, or who can attend, the opportunity of visiting at least one of these great shows. It is, however, sadly true, that only a very small percentage of our club members ever make the effort to take in a convention. This great majority of 'stay-at-homes' are of course the principal losers, however, indirectly at least, we are all the losers on account of their absence.

One fact which we should here like to impress upon our readers, is that non-club members are fully as welcome to attend such conventions, or the many fine local mineral shows, as are club members themselves. Mineral clubs and societies are not secret or exclusive organizations—on the other hand they will be found to be very democratic.

All students, mineral fans, or rockhounds residing in small cities or villages, or on farms or ranches, where no clubs conveniently exist, making the effort to attend, will indeed be very well repaid. The inspiration they will receive, the friends they will make, and what they may learn, even if one is unable to attend more than a day, will be very much worthwhile. Perhaps, it would be only fair to mention that in most instances, club membership is required when entering competitive exhibits.

Just what does one see or do at a convention, is a question frequently asked by those who have never attended. Just what does one get out of it? In a way this might seem to be a foolish question, however we shall attempt to answer it at least partially. To list and discuss all such benefits would 'fill a book.' Indeed most folks already know the answer. In a general way we might say, one will get out of it just about what he puts into it. Likewise, to attempt to list such in the order of their importance, also would prove to be a futile effort, for what might seem very important to some, might appear only trivial to others. This, of course, would depend largely upon ones individual interest.

Beyond this we might say, going to a convention breaks the monotony of staying at home all of the time, adds to the zest of life, gives one something to look forward to, and something to look back upon with pleasure. What more could one expect? However, on the more serious side, it also gives one the opportunity to attend interesting lectures, to take field trips to places of special or unusual interest, to admire and to study the many fine individual exhibits. He may also pick up new lapidary and other ideas, exchange specimens with others, and last but not least visit with the dealers, where he will be able to purchase rare minerals and materials that he may have been looking for for years, and which are not obtainable elsewhere. Here, too, he may actually see and select what he is buying.

What more need be said—now go and pack up that old suitcase, gas up the old car and take off for some convention, where a wonderful time is assured you.

* * *

*Making Colored Flames for Fireplace:* One of the most interesting and in some cases most dependable observations when examining and testing minerals for their identification is the "flame color test." Much has been written concerning it in the literature, and the "whys and wherefores" involving the nature and composition of light is a subject which has intrigued scientists, particularly physicists, for centuries.

It also holds many important industrial and commercial possibilities. Red, and other colored flares are important items of trade, and who has not been charmed by the magnificent pyrotechnic displays (fireworks) sometimes seen on the fourth of July, or on the occasion of other celebrations. The Chinese have been artists in this field of endeavor for more than a thousand years.

Here are a number of chemicals which may be added to shellac and variously applied. It may be painted or sprayed directly on the firewood or mixed with sawdust or other combustible materials before using.

| | |
|---|---|
| Violet flame | Potassium chlorate |
| Yellow flame | Potassium nitrate also sodium chloride (salt) |
| Orange flame | Calcium chloride (de-icer) |
| Red flame | Strontium nitrate |
| Apple-green | Barium nitrate |
| Emerald flame | Copper nitrate also "blue vitrol" |
| Green flame | Borax |
| Purple flame | Lithium |
| Blue flame | Zinc sulphate |

And incidentally, by various experimentations along this line Rockhounds may actually learn many new and interesting things about testing for minerals. Buy yourself a blow pipe kit, with an instruction book and get busy. You'll be surprised how this will fascinate you.

* * *

## FILM FOR A BIG PROGRAM

"THE BIG Z", a film produced by the Ontario Department of Mines in co-operation with a number of interested mining companies and now ready for release, tells the story in unforgettable terms of the discovery and development of the fabulous Blind River uranium area.

The picture, which was nearly two years in the making, takes the viewer through the geological age two billion years ago that resulted in the deposition of the uranium-bearing conglomerate in the shape of a giant letter Z from which the picture derives its name, to the discovery of the radioactive element, the "back-door staking bee" in which thousands of acres were tied up in mining claims, and the evolution of the world's greatest uranium mining area to its present status. Seven great mines are now in production there and five more will be adding their contribution to the world's supply of atomic power within the next few months.

"The Big Z" gives a camera's eye view on surface and below ground of the mighty operations which in only four years transformed the area around Elliot Lake from untracked wilderness into one of the busiest spots in Canada, and which have led to the establishment of a full-scale city to accommodate the families of the miners.

The picture, produced by Showcase Film Productions and directed by Jack Chisholm, is fully Canadian in every sense of the word. In it Canadian technicians tell the story of one of the greatest of Canadian achievements.

Associated with the Department of Mines in its production are the Rio Tinto Mining Company of Canada, Limited, Stanleigh Uranium Mines, Limited, and the Joy Manufacturing Company.

This picture, like "The Claim Stakers" released a few weeks ago and others in the Department's film library, is available for free loan to any interested groups wishing to borrow it. For reservation arrangements address, The Department of Mines, Ontario, Canada.

*Still a conundrum!!!* During a lecture on the theories of origin of the Red Beds, the late Professor Ermine C. Case of the University of Michigan observed a student dozing off.

"Wilson," he said, "tell us how the Red Beds were formed." The awakened student gulped and then said, "Well, Dr. Case, I knew the answer once, but I've forgotten."

"A pity," said Professor Case. "A great pity. You were the only person to have the answer—and you've forgotten!"

* * *

*Yes, and an enigma!!* "You must inevitably give up the Old Red Sandstone," said a foreign geologist to Roderick Murchison. "It is a mere local deposit, a doubtful accumulation huddled up in a corner, and has no type or representative abroad."

"I would willingly give it up, if Nature would," replied Murchison, "but it assuredly exists, and I cannot."

* * *

## Book Reviews

GEM TUMBLING AND BAROQUE JEWELRY MAKING (New Second Edition), By Arthur Earl and Lila Mae Victor: Published by Victor Agate Shop, 1709 S. Cedar St., Spokane, Wash. $2.00

Are you interested in building a tumbler of your own, or learning the secrets of jewelry making? Possibly you are just interested in picking up a few pointers on either or both subjects. If so, this 48-page booklet, copyrighted in 1957, will help you. It is one of the most compact and interesting publications we have noted on these subjects. The Victors are well-known experts in their field.

Detailed instructions on tumbling, in clear and easy-to-follow language, start on the very first page and carry through each step of each tumbling operation. Pictures of the equipment in action, together with formulas for determining proper pulley sizes, belt lengths, tumbler speeds, etc., help in following the text. A detailed description of the proper grits to use, length of time required for each, and selection of proper types of stones for tumbling round out the story of how to produce perfectly polished gems in your own basement.

The basic principles of baroque jewelry making are set forth in the last 10 pages. Some terms you have been wondering about are explained and there are many helpful hints to assist you in turning out creditable work. E.D.C.

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# New Horizons With the V-Lock

*by* **GUS BROWN and DAN FINCH**

IT APPEARS to the authors that the future of the lapidary hobby lies in the direction of newer and better methods of display, design and construction. Members will be increasingly attracted to the hobby by the artistic and aesthetic potentials of our natural stones and the development of new ideas in our uses of equipment, rather than by following the footsteps of those who facet.

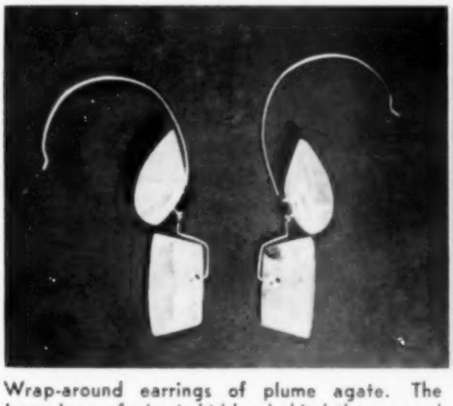
A number of members of the Des Moines Lapidary Society have been experimenting and studying the uses of the V-Lock mounting method for over three years. We have made exciting progress. This article is to be a report of that progress to date. (Full details of constructions were published in Sept.-Oct. 1956 issue of Earth Science.*)

*Single copies of this issue are available from publishers. Price 35 cents.

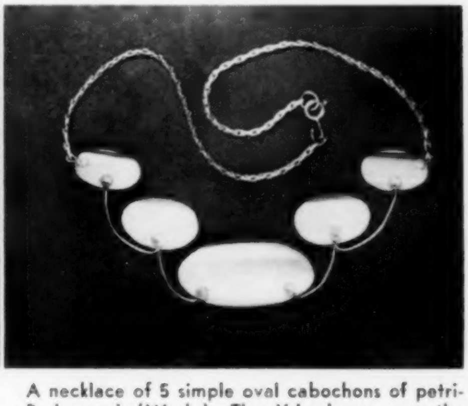
We find that the V-Lock is a quick, new and easy permanent method of mounting and using cabochons, free forms and flat-forms. It has two important advantages which should be emphasized:

First: Designs may be opened up, stones may be placed in any relative position with quantities of space between. Second: The stones may be supported at any angle from any point (with drilling, bell caps or wrap-around wires invariably it is necessary to hang the stones from a fixed point.)

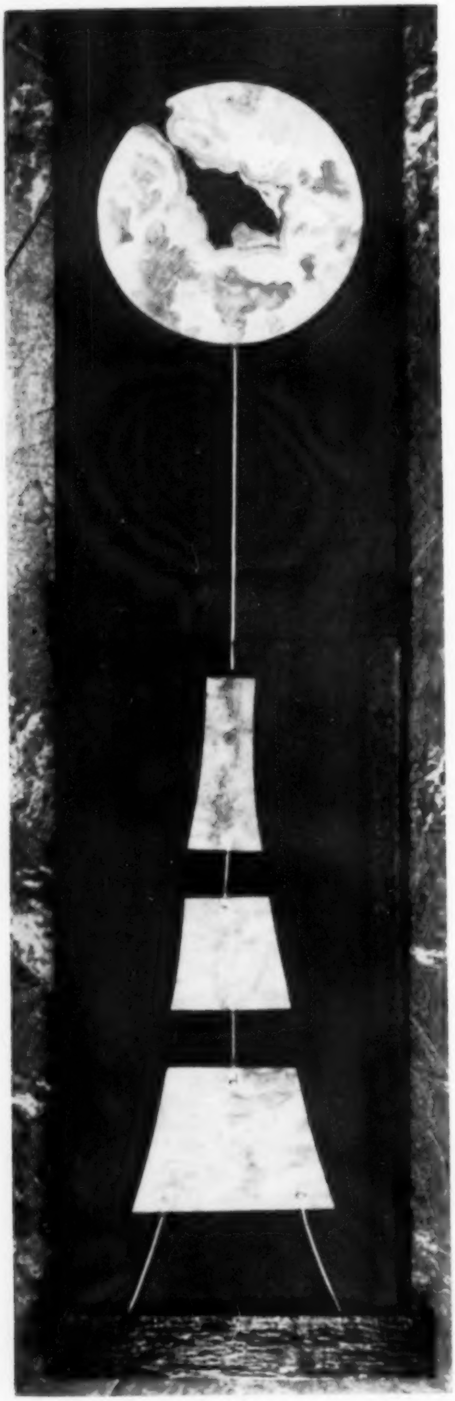
Since this is true—we can speculate along lines related to the thinking of the painter, sculptor and florist. We can think of mobiles, wall plaques, table decorations, constructions and transparencies as well as of new style designs in jewelry.



Wrap-around earrings of plume agate. The large loop of wire is hidden behind the ear and the pear shaped cabochon covers the ear lobe. The lower stone dangles.



A necklace of 5 simple oval cabochons of petrified wood (Wash.). The V-Locks are on the bottom and sides.



An interesting wall plaque of plume and tube agate.

By this method of display we can seemingly overcome the forces and in some respects the disadvantage of gravity itself.

Perhaps you will understand better if we quickly review the construction of a V-Lock.

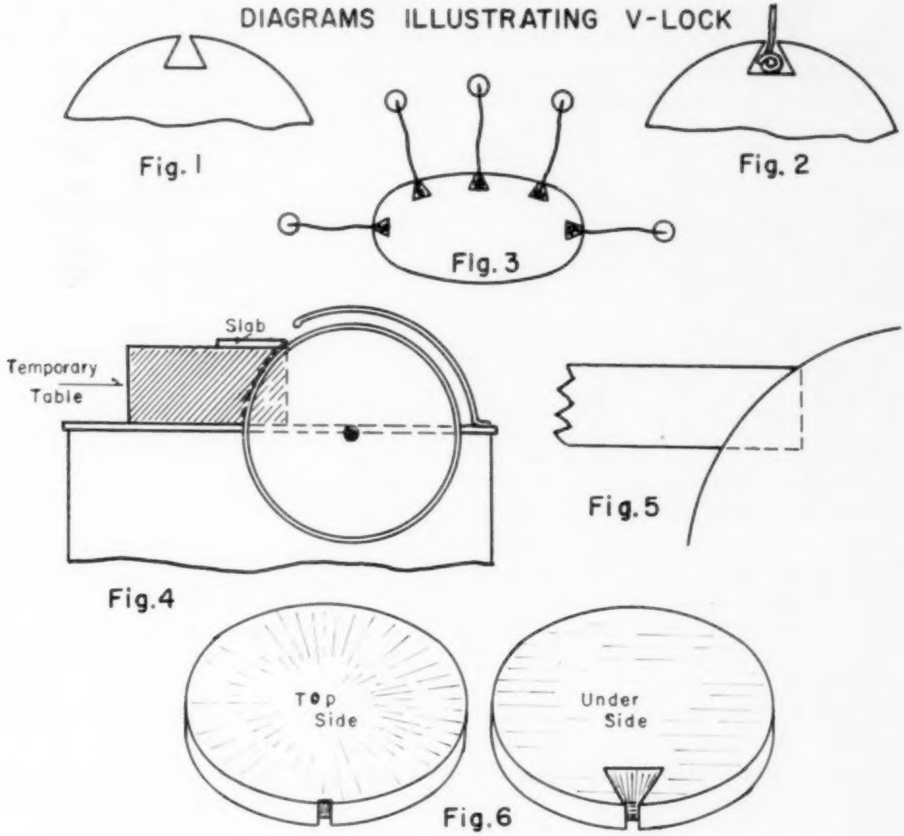
The stone is cut and polished. Then several adjacent cuts are made into the stone at different angles through one point so that the cut will be widest towards the center and narrower at the edge. See diagram Fig. 1.

Next the end of a piece of wire is so bent and twisted that it is wider in *two* or more planes and of such a size that it can be inserted into the V-cut from the side. See diagram Fig. 2.

At this point cover the cut with your fingers. You should be unable to pull the wire through the narrow edge of the cut in the stone. The cut is next filled with cement and after drying and hardening you have the stone *permanently* fixed to the end of the wire. This takes two or three minutes actual working time. The stone may thus be supported in any position. See diagram Fig. 3. You can now see that this is something new and different, that designs may be opened up and new effects created. Look at the photographs and you will get a better idea of a few of the possibilities of the V-Lock.

A recent development has been the discovery of the modified V-Lock in which the cutting is done on the side and back of the stone and the face is left unmarred. You do not need a special thin bladed trim saw as the cut may be made on the usual standard six or eight inch trim saw. Place a block of metal or similar material on top of the table of your trim saw so that it makes a new temporary table several inches higher. See diagram Fig. 4. Now make the V-cut as originally described. See diagram Fig. 5.

## DIAGRAMS ILLUSTRATING V-LOCK




The wire is bent somewhat differently but be sure the end of the wire is wider in two or more directions than the cut at the end on the stone. This cut is very suitable for small stones such as we use for most jewelry and small objects. It is not quite as satisfactory or as strong for larger constructions.

Another improvement we have made is with the cementing agent. The original article mentioned the use of plastic metals as used in the automotive body fender repair shops and the use of model alloy and mercury amalgam as used in the dental profession. The mercury silver amalgam makes an extremely strong bond but it takes longer to mix. The proportions of the two ingredients are somewhat critical and the amalgam must be pressed into the cut and onto the wire with some force. This material is best for such things as finger rings or large slabs weighing eight ounces or more or whenever an exceptionally strong bond is needed.

There is an Acrylic plastic material used by the dental profession. It is called Biofast made by the B. L. Dental Company of New York, and available from your dentist or from a dental supply. (If your dentist is not yet a rockhound.) It consists of a pale pink powder and a liquid. Mix a little of each together in almost any proportions to make a paste and apply with a small camels hair brush. It sets in six to eight minutes, requires no heat or pressure and makes a good hard and tough bond. This is now our most popular cementing agent. It has an additional advantage of being translucent and therefore picks up some of the color of the stone. It can, if you wish, be sanded by hand and polished with chalk or toothpowder.

Without a doubt, the most exciting and spectacular construction we have made with the V-Lock is something new and different — called a Halo-transparency. The first one was made by one of us (D. F.) with the able assistance of Dr. Arthur Maris and others. It is basically a shadow box transparency but the slabs are polished. There is no glass used and around each stone and around the box there is a halo of light which makes it brighter and livelier and with a strong three dimensional appearance. Also, by varying the amount of light within the room you may vary the effect.

In a Halo-transparency the glass is replaced by plywood in which holes are cut that are ¼ inch smaller than the outline of the polished slabs. The polished slabs are mounted with three or four V-cuts and pieces of wire about one-quarter inch in front of the plywood. Diagrams 7a, 7b and 8 show details of construction.

We plan to have for display at the coming show of the Midwest Federation at Downers Grove on June 19 through 22nd, one or more Halo-transparencies, and this will be just another small reason for you to attend.

Also the Des Moines Lapidary Society is planning a big rockhound round-up on Oct. 19th and 20th at the Veterans Auditorium in Des Moines and among many exciting features will be a great variety of lapidary objects made with this new method.

We have two basic methods of working with the V-Lock. One method is to start with paper and pencil and sketch or doodle until we suddenly get an idea. We work on the sketch a little and then start in the rock room with suitable slabs. We invariably keep changing the designs as we progress through the various stages of cutting and grinding to shape, and attaching the wires, and often the finished object has but little resemblance to the first sketch. This method is especially adapted to multiple stone construction.

The other basic method we use is to start by studying some slab of rock—making pencil sketches on the rock and then start right in cutting and making sketches at the same time. This method is very useful for our problem children;

## TRANSLUCENT SLAB DISPLAY

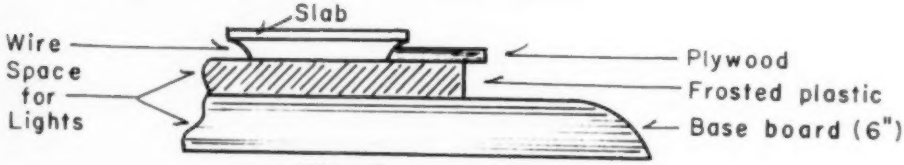



Fig. 7a (Detail)

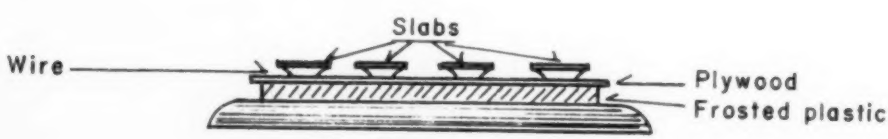



Fig. 7b (Side view)

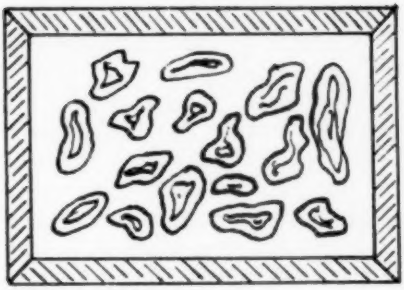


Fig. 8 (Top view)

i.e., those choice slabs which have beautiful color and design but bad spots in the most unwanted places. Sometimes we can so make our design that the V-cut is placed at this delinquent spot. Or sometimes we can see ways to completely cut our theras-callion and utilize the balance of the slab with happy creative romp and recompense and another good reason to get together with our friends and tell them of our latest escapade and with the proof to back it up.

Authors of this article are active members of the Des Moines Lapidary Society. Gus Brown is regional Vice President of the Midwest Federation. Drawings are by Dan Finch.

## "Rocks and Fossils"

**by JEFF HAVILL, (Age 10 years)**
**Park Falls, Wisconsin**

I collect fossils, I collect rocks
I collect by the desert,
  I collect by the docks.
I always keep an eye out, for
  I collect them here and there,
And before you know it, I can say
  I've collected everywhere.

I'll collect them while I'm little
  I'll collect them when I'm tall
I'll collect them every year from
  The Spring until the Fall.

Some day I hope I'll find with luck
  a great big dinasaur,
Far out in Old Wyoming,
  or on some unknown shore.
I'll find fossils in the southland,
  and lava in the west, and
Perhaps I'll dig so deeply,
  I'll find a Treasure Chest.

◆ ◆ ◆

Editor's Note: Jeff writes that he got bored while taking his examination one day in school and wrote this verse. May Jeff's dreams come true, why not send him a few minerals or fossils. B.H.W.

# Crystals and Optical Instruments

***by* KEITH A. PIERCE**

IN THE Russian Exhibit at the World's Fair in Chicago, 1893, John Brashear, the most able optician of the era, discovered several magnificent salt xls which were secured by S. P. Langley, director of the Smithsonian Institution, and one was fashioned by Brashear into a five inch lens and a 5 x 7 inch 60 prism—something unheard of heretofore as to their dimensions. They served Langley well in his pioneering researches on the long wave (heat) radiations from the sun.

Any transparent crystal is potentially useful to the optician and research worker. Some are valuable because of their transparency to infra red light—halite, fluorite, sylvite; others because they transmit ultra violet light—quartz, fluorite, calcite, selenite, etc. In both cases ordinary glass is opaque or nearly so.

Natural rock salt crystals are quite stable but once ground and polished on a plane other than a natural crystal face they become very deliquescent, frosting over within hours in a damp climate. In spite of this disadvantage, because of their great transparency to heat radiation, they find everyday use in infra red spectrometers. The prisms are transported in desiccators, or bell jars. When removed and put in use, care is taken to keep the prism warmer than the surrounding air since this inhibits their deterioration. Often the spectrometer is sealed and flushed with dry nitrogen to help preserve the crystal faces. Russia is no longer the principal source of halite crystals. Now, large and perfect crystals are grown in the laboratory from hot melts.

Quartz is the optician's favorite medium. As the lapidary knows, it works well and polishes well. It is available in large, optically-clear pieces and best of all it transmits a large fraction of the ultra violet spectrum. Fluorite is somewhat better in this last respect, but clear pieces of natural fluorite are practically unobtainable. Quartz prisms serve the steel industry in the rapid analysis of alloy steels; the crime detection laboratory, for the detection of minute traces of compounds and elements; and the astronomer, in the analysis of ultra violet light of the sun and stars.

Tourmaline is one of a number of minerals which can produce polarized light by selective absorption. When a beam of ordinary light is sent through a thin slab of tourmaline, the transmitted light is found to be polarized. A fact which can be tested with a second crystal plate. It is observed that light can be sent through two plates in series if they are oriented so that their axes are parallel. But if the second plate is rotated 90°, no light is transmitted by the pair. Hence, one acts as a polarizer and the other as an analyzer. Tourmaline crystals are generally colored and therefore not as useful in optical instruments as might be desired.

Calcite, Iceland spar, is one of a number of minerals which can produce polarized light by double refraction. When a narrow beam of ordinary light is sent through a slab of calcite, the transmitted light is found to be split into two beams, each polarized. By properly cutting the rhomb, one beam can be deviated to the side, letting only one direction of polarization pass through. Two such prisms, called Nicols, form a polarizer and analyzer and serve as a powerful analytical tool.

Substances placed between polarizer and analyzer can affect the state and direction of polarization. For example, if a one millimeter thick plate of quartz is used, the plane of polarization is rotated about 30 degrees. Thus, the analyzer must be rotated 90° +30° or 120° to stop all light. Other materials rotate the plane different amounts. This property of rotary power is widely used in industry as an accurate means of determining the amounts of sugar present in solutions. The instrument is called a Saccharimeter.

The light of the blue sky is rather strongly polarized by scattering of light from air molecules. This property is easily determined with Nicol prism and is daily used by bees, to determine the direction of their flight to and from the hive. —Their eyes, it has been shown, are able to analyze polarized light.

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From the Conglomerate: Bulletin of the Michigan Mineralogical Society.

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**From *"On A Piece of Chalk"* by Thomas H. Huxley (1825-1895). "I weigh my words well when I assert that the man who should know the true history of a piece of chalk, which every carpenter carries about in his breeches-pocket, though ignorant of all other history, is likely, if he will think his knowledge out to its ultimate results, to have a truer, and therefore better, conception of this wonderful universe, and of man's relation to it, than the most learned student who is deep read in the records of humanity and ignorant of those of Nature."**

# CAVES—
## *Origins and Features*

*By* **L. D. Prewitt**

TO MANY people, caves are among the most interesting of the earth features and to enter one of these cracks or holes in our earth's foundation is an enjoyable experience. Animals lived in them, robbers hid loot in them, and small boys are always fascinated by their dark, unexplored recesses. The fact that millions of dollars are paid in admission fees into commercial caves each year shows that this interest is retained into adult life.

Caverns have been the traditional dens or winter hibernation homes of wild animals, but they are mainly known as ideal bat roosts, with resulting guano used commercially for fertilizer and in earlier days as a source of salt petre for gun powder. Other cave life includes crickets, beetles, salamanders, fish and crayfish, usually characterized by a general loss of color and a degeneration of the eyes, often resulting in complete blindness.

Temperatures in caves vary greatly from below freezing to above seventy degrees. As a rule, however, the temperatures are from 55 to 60 degrees; and there seems to be some connection between the annual mean temperature outside the cave and the more or less constant temperature within. Individual caves vary little in temperatures regardless of the seasons.

Most caves are found in limestone; or in dolomite, gypsum or marble, related to limestone. There are some caves in sandstone, usually made by running water, and a few tubular caves made by lava action.

All limestone originated in ancient seas where the water contained much calcium carbonate or lime. This lime was precipitated or dropped to the bottom by chemical changes in the water. The growth of algae removed carbon dioxide from the water causing the water to lose part of its lime. Some limestone is called oölithic by reason of the fact that it is largely composed of small calcareous concretions about the size of a grain of sand, thought to have originated by inorganic precipitation. Occasionally bones and shells falling to the bottom were preserved as fossils in the limestone. The pressure of other strata washed in above the lime and the weight of the water solidified the ooze into limestone as we know it. A bed of limestone 1600 feet thick is known in northwest Wyoming.

The next step was the uplift of the ocean bed. The terrific forces of the earth's interior as re-adjustment of pressures occurred lifted the limestone high above the water and often into mountain ranges. This uplift caused cracks to occur in the limestone, some large and some small.

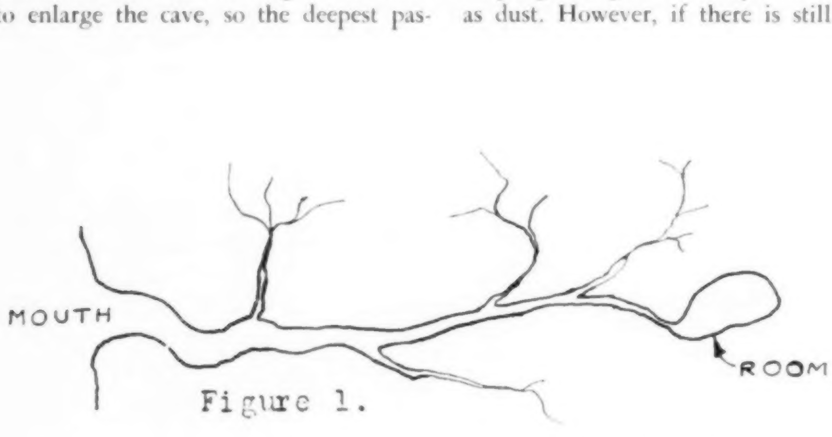
Rainwater would then attack these perpendicular cracks and also weaknesses in the horizontal bedding planes caused when the limestone was being laid down. Pure rain water contains a little carbon dioxide, and at earlier times in the earth's history it may have had more than at present. This rain, soaking down through the earth and picking up acid from decaying vegetation attacked the limestone in the lines of weakness and dissolved or leeched away some of it, making the cavities. This process would take place no matter how hard the limestone might be.

There are two theories concerning the making of a cave. The one cycle theory holds that the cave is made and enlarged by the action of the fresh or vadose water in the areation zone above the saturation area at the ground water level. In the two cycle theory it is thought that the cave is formed by the standing or phreatic water in the saturation area at the ground water level and below. It would seem probable that under favorable conditions the leeching processes would take place in both areas.

The largest chambers in caves are usually found where the water was freshest or in greatest volume. The leeching process in a perpendicular crack tends to make a long, narrow and high passage, often called the "life-line" of the cave. But if the water enters a horizontal bedding plane the galleries tend to be wider, but not so high. As the water accumulates in the cave, it forms into a stream at a low level and then scouring action tends to enlarge the cave, so the deepest passages frequently show evidence of stream erosion and wear. Mammoth Cave in Kentucky and Carlsbad Caverns in New Mexico are both claimed as the largest cave. The largest reported chamber is in Carlsbad.

Various cave levels are caused by changes in the ground water level. This change may be caused by an uplift of the region with resulting rejuvenation of streams, or the control stream nearby may find a lower level, or this master stream may gain or lose water through stream piracy.

Clay or silt in limestone is not acted upon by the leeching water and so is left behind on the floors and in pockets in the chambers. If there is little or no present water seepage into the cave, it will be known as a "dead" cave, since it is no longer growing and the clay will be found as dust. However, if there is still water



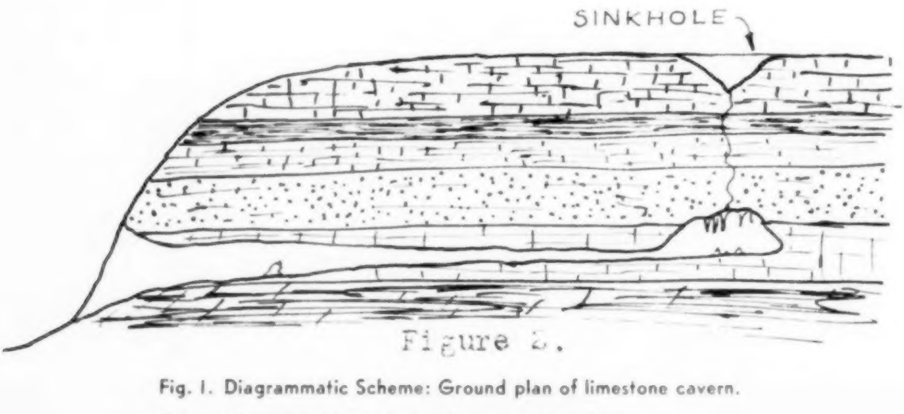




**Fig. 1. Diagrammatic Scheme: Ground plan of limestone cavern.**

**Fig. 2. Diagram: Vertical elevation of typical limestone cavern.**

action, the cave is called "alive" and will probably be somewhat muddy.

As the water which makes the cave seeks a lower level, the upper passages and cavities fill with air. Then the secondary life of the cavern starts with the resulting formations which make caves so beautiful and attractive. Seeping water removes calcite or calcium carbonate from the limestone and deposits it where there is evaporation. This results in the cementing of the cave with calcite and so makes the ceilings and walls stronger with fewer ceiling falls.

The calcite depositions have the technical name of speleothems and often take fantastic and beautiful shapes. The depositions made by dripping water are called dripstone. Calcite in a drop of water tends to form a film around the outside of the drop, so, when the drop of water breaks, it leaves the calcite film behind and this forms a hollow tube-like pendent, which may grow to great length resembling a soda straw. When the hollow tube fills or plugs, the pendent grows on the outside and makes a stalagtite which is suspended from the place of the drop. Not all the calcite is deposited there, however, and when the drop of water hits the floor, evaporation takes place and a stalagmite is formed, not as slender as the stalagtite, but larger in circumference, denser, and of slower growth. If the processes continue long enough, the two join in a resulting column.

The term "flowstone" is applied to the depositions left by moving water which evaporates, leaving the calcite on the contour of the cave walls and floors. These are given various names, limited only by imagination, such as ribbons, folded draperies, shields, grapelike clusters, rimmed basins, flowerlike formations, cave pearls in lily pads, etc.

Occasionally the calcite forms a "helicite," which grows upward and outward in seeming defiance of the law of gravity. Often these assume a plant-shaped form. The cause for this is not definitely known, but it is thought the growth may be influenced by air currents, capillary action, or by the crystals of growth turning on their sides.

The calcite depositions are often colored or banded by magnesium, iron, organic salts, other chemicals and discolored clay. Compact, banded varieties of this travertine, as it is called, capable of taking a polish, are often called cave onyx or Mexican marble. Calcite removed from a humid atmosphere will lose its luster and beauty. Here the collector and the cave speelunker may come to blows, the collector wishing a sample of the material and the speelunker insisting that nothing within the cave be removed.

Occasionally aragonite will form in a cave in the shape of needles or hair-like formations on top of calcite. The reason for this is not known unless it is caused by a change in temperature.

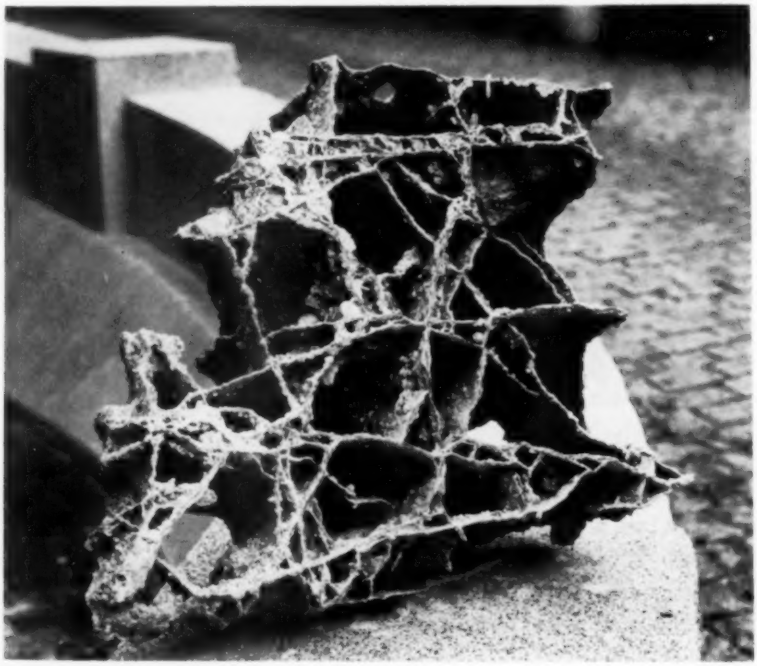
The rate of growth of the calcite deposition depends of course upon the volume of water, concentration of mineral content, rate of drip and evaporation, and the nature of the chemicals within the water. So, it is impossible to do other than estimate the age of the speleothems. Here again the imagination of cave guides is prone to reach extremes.

A readily discernible movement of air may be noticed at the mouth of some caves. Such caves are said to be "blowing" caves. This is caused by changes in the barometric pressure of the atmosphere. The changes in the pressure outside must be compensated for by the air within the cave. If there is sufficient air space within the cave and the openings to the cave are narrow and small, then the equalizing of the air pressures causes a strong air movement. Wind Cave in the national park in the South Dakota Black Hills is a good example of a "blowing" cave. This cave is so large it has never been completely explored and the air movement at the cave mouth often equals a strong wind velocity.

Another feature unique to Wind Cave is its so called "box-work" calcite formations, not equalled elsewhere. This unusual type of formation is caused by a series of natural events. When the area in which the cave is located was subjected to an uplift the pressures were so intense that the limestone was shattered with resulting countless small cracks and breaks throughout the limestone. These cracks were later cemented together with calcite by water evaporation before the cave was made. Later, as the chambers were made by the leeching water, the coarsely-crystalline calcite veins resisted the leeching action a little longer than the fine-grained limestone. So the walls and ceiling of the cave are in places lined with interlocking calcite resembling postoffice boxes or honeycomb. The supply of water then dried so the cave has no stalagtites other than a few small ones in the lowel levels where a small "lake" a few feet across may be found. In the highest levels of the cave where no shattering of the limestone took place, the box work is absent.

Other unusual caves include Kiser cave in Mason county, Texas, which discharges deadly carbon dioxide gas from its mouth. The cause for this is not known. Near Burnsville in Bath county, Virginia, is a "breathing" cave where the air moves in and out of the cave entrance in cycles of a little over eight minutes. The explanation for this is also unknown, but it might be caused by a natural siphon emptying water from a pit with a resulting filling and emptying of the pit with air. This siphon action might also account for the more or less regular rise and fall of the

(*Continued on Page* 25)



**Boxwork formation from ceiling of Wind Cave National Park, Hot Springs, South Dakota, National Park Service.**

# Typical Rock Forming Minerals

## *(Series IV)*

*by* WILLIAM H. ALLAWAY and EARL D. CORNWELL

IN FORMER articles of the series the three great classes of rocks—igneous, sedimentary, and metamorphic have been described and something has been told of how they were formed, indicating that certain rock forming minerals were involved in the process.

Although there are approximately 2000 different minerals which have been identified, only about twenty of this number are considered as important rock forming minerals. These are listed as follows:

| MINERAL | EXAMPLE | MINERAL | EXAMPLE |
|---|---|---|---|
| Feldspars | Orthoclase | Serpentine | Asbestos |
| Feldspathoids | Sodalite | Kaolinite & Clay | Kaolinite |
| Pyroxenes | Augite | Quartz | Rock Crystal |
| Amphiboles | Horneblende | Hematite | Specularite |
| Micas | Muscovite | Magnetite | Lodestone |
| Olivine | Peridote | Calcite | Iceland Spar |
| Epidote | Epidote | Dolomite | Dolomite |
| Garnets | Alamandite | Gypsum | Selenite |
| Chlorite | Chlorite | Anhydrite | Anhydrite |
| Talc | Stealite | Halite | Rock Salt |

If rocks formed from these most common minerals could be recognized in their crystalline state, or when existing together intimately as a mixture, this would be a big advancing step for the beginning petrologist (student of rocks). This too, it would seem, should be a very good starting point for studying rocks, analyzing their composition, and learning something concerning how they may have been originally formed by nature. Such, if seriously studied, surely would take one a long way into the science of rocks, especially of their identification and history.

### Contemporary Rock Formation: (Igneous)

It would be most natural for a person who had never considered the question seriously to regard all rocks as the result of earth forming phenomena that took place many millions of years ago, back even at the beginning of geological time. This, however, is not always the case as these rocks may perhaps be forming today, just about the same as they were in the beginning, and of course by the very same processes. Such activity may be observed many places on the earth by those who have time, money and the inclination to visit such areas. Many active volcanoes are now ejecting their red hot molten magma from their craters, which on cooling becomes lava (igneous) rocks containing the same rock forming minerals that are present in the most ancient rocks that were formed earlier in the earth's history.

Rocks thus produced from the molten magma may take on many different forms, depending on their chemical properties, rate of cooling, environment, and many other factors which we might mention. Such rocks are formed as obsidian or volcanic glass; perlite, which is volcanic glass with concentric shell-like structure; pitchstone, being similar to obsidian but duller in appearance; scoria and pumice which are frothy or sponge-like in appearance; rhyolite and basalt which are the fine grained denser rocks. Great quantities of volcanic dust or ash produce deposits which later may become what is known as tufa and the coarser volcanic material becomes volcanic breccia. Volcanic bombs, so called, are likewise blasted from volcanic craters.

### Contemporary Rock Formation: (Aqueous)

(Sometimes called Sedimentary or Stratified Rocks)

For the purpose of illustration let us select some one well known location to be cited as an example. Along the ocean shore a few miles below Santa Cruz, in California, high cliffs rise abruptly from the beach. To the casual observer they seem to be the usual loosely consolidated sandstone that so frequently occurs along the ocean.

Closer observation, however, discloses that layer after layer of sea shells exist all the way up the cliff. These must have been at one time deposited in the bed of a sea. At some later period the land in this area probably rose so rapidly that there was little time for these particular beds to become consolidated into a true bed rock formation. However, further inland other beds or layers of the same types of shells are found to be actually solid rock.

This is an illustration of the early stages of rock building occurring before sufficient induration by such agencies as heat, pressure, and other known causes have taken place to consolidate them into true bedrock. Reactions of certain chemicals no doubt present in the rock forming minerals seemingly were inactive, this being probably due to absence of sufficient time.

Another example of present day rock forming processes may be observed in any of the many limestone caves located throughout the country. Here the dripping water forms a fairyland of hanging spears and curtains by depositing lime layer upon layer as a result of evaporation of the calcium ladened waters to form stalactites and stalagmites. The former hang from rocky ceilings and the excess dripping to the floor, build layers of travertine until spikey stalagmites grow up and eventually join the stalactites to form weird columns of solid stone.

### Contemporary Rock Formation: (Metamorphic)

When either igneous or aqueous rocks are perceptibly altered or changed by such agencies as heat, pressure or chemical action, it is said that metamorphism takes place and the new forms are classed as metamorphic rocks.

In the igneous rocks the changes are perhaps not so pronounced, though not uncommon, and granites, etc.—are altered and become gneisses or schists. In the aqueous rocks—limestone may become marble; sandstone may become quartzite; shales may become slates, etc. When finally the processes of metamorphism are carried so far that one can no longer tell from the appearance of a rock just what its primary origin or condition may have been, it is said that the *Rock Cycle* is completed, and the process then starts all over again.

In most areas the time element may have been extremely long, as much as a billion years, or on the other hand as in the presence of extreme volcanism, it may have been relatively brief.

The rock forming minerals such as quartz, feldspar, mica, etc., are primarily of igneous origin. In the rock cycle

(*Continued on Page* 21)

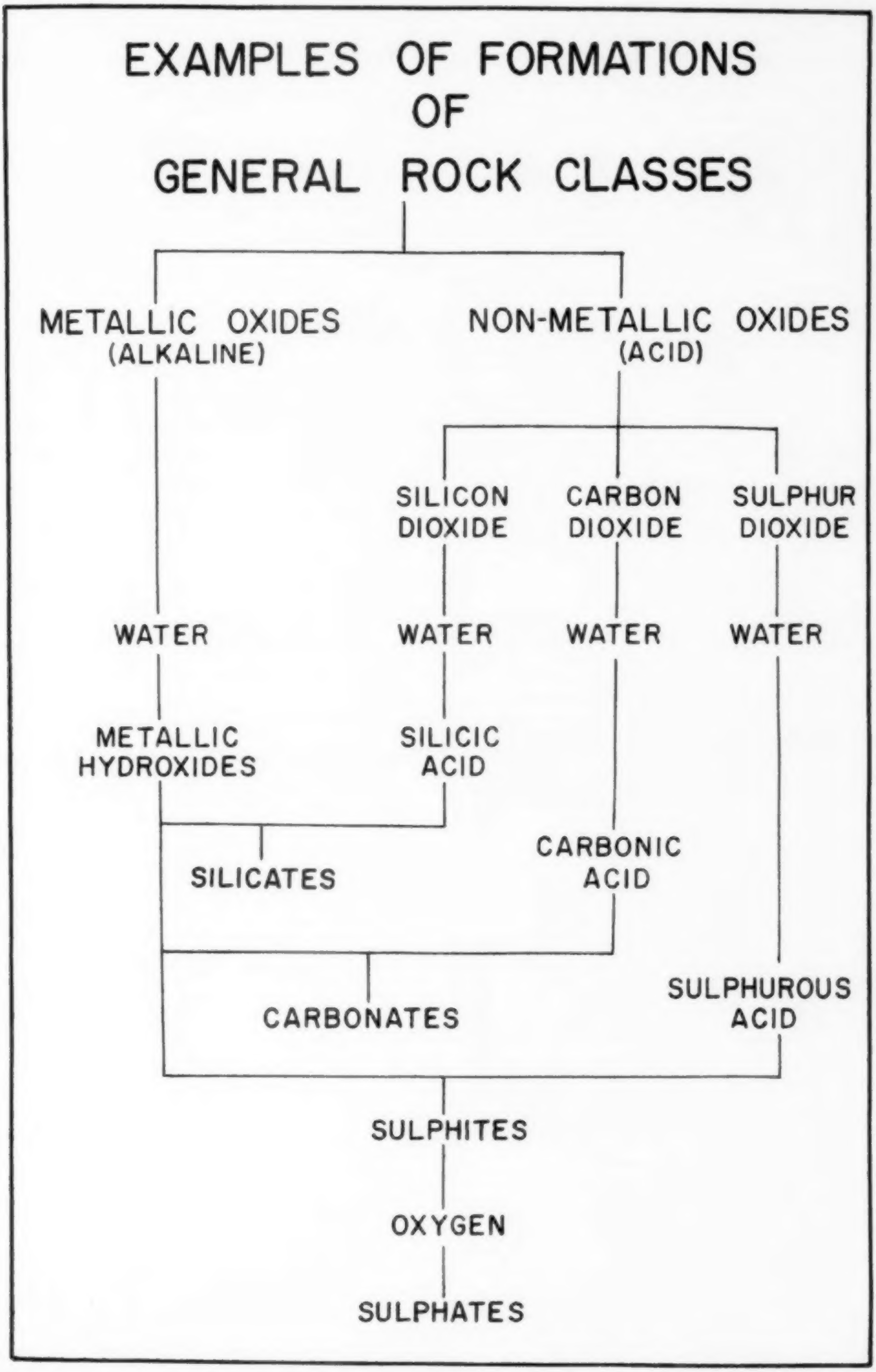



Fig. 1 Chemical Basis for Formation of Mineral Compounds

(*Continued from Page* 18)

process the igneous rocks are eroded and reduced to fine particles, which are redeposited as silt, sand, gravel, and small pebbles, all of which may later be consolidated by heat, pressure, and chemical action into the sedimentary rock series. In this process calcium, silica, and iron often play an important role as cementing agencies.

When silica ($SiO_2$) acts as a rock forming mineral it combines (combining usually refers to a chemical union) with other minerals or elements in solution along with oxygen to form what is referred to as silicates. Thus silica would combine with sodium and aluminum to form "soda" feldspar; or, potassium and aluminum to form "potash" feldspar. These and other silicates are the most numerous minerals. Altogether they make up about 59% of the earth's crust. Should there be an over abundance of silica present in the melt or solution much free quartz (silica) remains, as is evidenced in the granitic rocks.

Rock structure (texture) refers to the internal structure of the "what have you." It is never simple as it embraces so many variables such as composition of the rock forming minerals, their texture, arrangement and size of the molecular lattice pattern, all of which dictate the shape of crystals.

Involved also are the classes of rock which may be of inter-related or in process of change from igneous to metamorphic, etc. Such terms as granite or gneiss attempt to define in a general way various assemblages of minerals. It is indeed very difficult to find several authorities all in complete agreement on the descriptive terms branching out from such name as granite, and so this we must leave for some future discussion.

### The Chemical Basis of Formation

The chemical basis for all rock formation is the chemical union of alkaline solutions with acid solutions to form new mineral compounds.

Most of the metallic oxides form alkaline water solutions; for example, iron or ferric oxide in chemical combination with water (in solution) forms a compound known as ferric hydroxide which in the solid form is commonly known as limonite. On the other hand, the oxides of most of the non-metallic elements, such as silicon dioxide (common sand or quartz), form acid solutions when chemically combined with water. An example of such a compound is silicic acid or silica gel. Since we are discussing the chemical formation of minerals, the following paragraphs will explain the process somewhat more in detail.

All elements carry electrical charges. As a result, they are divided into two major groups, namely, (1) those carrying positive charges and (2) those carrying negative charges. The groups of positively charged elements comprise both

(*Continued on Page* 23)

(*Continued from Page* 21)

metallic and non-metallic elements. Due to the great affinity between oppositely charged particles, they chemically unite upon contact to form new chemical compounds. In this reaction, however, some of the elements are much more reactive than others. Oxygen is a good example of a fairly active "negative element" as seen in its reaction with iron to produce rust (iron oxide). Nitrogen, on the other hand, may be cited as a much less reactive "positive element."

Since oxygen is both active and abundant, chemical compounds formed between negatively charged oxygen on the one hand and positively charged active elements such as the metals on the other are very common. Such compounds are known as the "metallic oxides." Similarly, reactions of oxygen with the positively charged non-metallic elements such as silicon, carbon, and sulphur naturally form the "non-metallic oxides."

As a further explanation of this chemical reaction it may be said that the chemical union of any one of the alkaline metallic hydroxides (solutions of their metallic oxides) with any of the acid reacting compounds, such as silicic acid, will result in the formation of a "neutral mineral compound" which is chemically termed a "salt". In this particular case the compound would be generally classed as a silicate (see chart). Likewise, a similar combination of one of the alkaline reacting metallic hydroxides with a solution of the oxide of carbon (carbonic acid) results in the formation of carbonates (see chart). A third and very common example would be the reaction of such metallic hydroxides with the oxide of sulfur in the presence of water (suphurous acid) which would result in the formation of sulphites of the respective metals reacted. Further reaction of these products with the oxygen of the air would convert the sulphites into sulphates (see chart). The subsequent evaporation of water from these "salt" solutions would then result in the formation of the many types of minerals commonly found in nature as silicates, carbonates, sulphates, etc.

**(In an attempt to illustrate the chemical reactions discussed in the foregoing, a chart has been prepared by the authors showing the line of formation of the three most general rock-classes, namely, Silicates, Carbonates, and Sulphates. This should prove of value to lay-readers to whom the chemical basis for the formation of mineral compounds, may naturally at first appear to be more or less of a mystery. (See page 19.)**

(*Continued from Page* 16)
water level of lakes within some caves.

Although they do not approach the famous cave painting of Lascaux or Altamira of France and Spain, there are Indian paintings of good quality in the Hueco mountain caves northeast of El Paso, Texas.

Due to the softness of gypsum, caves with that mineral are often dangerous because of crumbling hand and foot holds. Unthreaded yet, the bead to close it up— ing the time when frost is leaving the ground. Chambers within the cave with rounded or domed ceilings are not as liable to have rock falls as those with a flat ceiling, due to the maturity and strength of the domed ceiling. An unaccompanied person should never enter a cave and exploration in groups would best be done with experienced "cavers" in the party.

Those who enjoy cave exploration are known as "Spelunkers" and they have a wild enthusiasm for crawling in mud and dust through narrow crevices and cracks and up cold steep walls; their way lighted by the flickering flame of a carbide lamp. They collect skinned legs, bruised elbows and knees with all the zeal of a "Rockhound" looking for specimens on a rocky slope a hot summer day. Just as the "Rockhound" struggles up a steep ridge on a sweltering afternoon to see what he might find at the top, so does the "Spelunker" wiggle on into the next chamber to see what lies beyond. Both groups have their clubs and meetings where those of similar interests gather to visit and talk over experiences. Maybe the "Rockhound" has a little more enjoyment in that he can cut and polish his specimens on cold winter nights; but the "Spelunker" finds as much satisfaction in knowing his hobby is a year-round one.

---

"Tennyson in Elaine says that Arthur, "the glorious King"
Had on his cuirass warm our Lady's Head,
Carved of one emerald centered in a sun
Of silver rays, that lighten's as he breathed."

"By the rushing fringed bank
Where grows the willow and the osier dank—
My sliding chariot stays
Thick set with agate."

Milton

---

"Another, ere she slept, was stringing stones
To make a necklet—agate, onyx, sard,
Coral, and moonstone—round her wrist it gleamed
A coil of splendid colour, while she held
Unthreaded yet, the bead to close it up—
Green turkis, carved with golden gods and scripts."

Edwin Arnold—"The Light of Asia".

* * *

"A thing of beauty is a joy forever;
Its loveliness increases; it will never
Pass into nothingness."

Keats

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